INITIAL REPORT

W9132T-04-C-0017

ReliOn, Inc.

Backup Power for Mission Critical Loads

Proton Exchange Membrane (PEM) Fuel Cell Demonstration
of Domestically Produced PEM Fuel Cells in Military Facilities

US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
Broad Agency Announcement CERL-BAA-FY03

Gabreski Air National Guard Base, Long Island, New York

June 29, 2004

Executive Summary

PEM fuel cells are an ideal source of backup power to critical loads requiring extended periods of run time. Numerous military applications must remain ready and functional, even in the event of a primary power outage. To further research these requirements, this application will test the reliability of the ReliOn fuel cell systems as sources of backup power for U.S. Military Telephone Communications Systems. The fuel cells will be housed in a separate outdoor enclosure. This enclosure will be entirely self-contained, providing hydrogen storage, hydrogen distribution, and a controlled environment for the fuel cell systems. The fuel cells are connected directly to the equipment's 48 Volt DC bus at each site. Once a day, AC power to the communications equipment will be disconnected, the fuel cell will start up and provide power to the load for 1 hour. After 1 hour, AC power will be restored and the fuel cells will shut down. Success will be measured by a system self-start in response to the outage and its ability to maintain a float voltage on the DC bus.

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Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

1.0 Descriptive Title

A demonstration of modular proton exchange membrane (PEM) fuel cells to serve as back up power for a mission critical communication system.

2.0 Name, Address and Related Company Information

Name:	ReliOn, Inc.
Address:	15913 E. Euclid Ave., Spokane, Washington 99216
Phone:	509-228-6500
DUNS:	137264193
CAGE:	3K7Y7
Federal ID:	91-2191190

ReliOn is a leader in the development and marketing of modular Proton Exchange Membrane (PEM) fuel cells. The company markets a variety of commercially available fuel cells using its patented modular cartridge technology™.

3.0 Production Capability of the Manufacturer

ReliOn is located in Spokane, Washington and is a provider of commercially available PEM fuel cell systems. One thousand watt models and outdoor enclosures are available today.

All Fuel Cell systems are assembled at the Spokane, Washington facility. The current facility has the capability to produce 10 fuel cell systems per week, running one shift and without contract labor. This capacity can easily be expanded with the addition of contract labor and back shifts. If demand exceeds this capacity, the production lines could be duplicated at contract manufacturers. Three contract manufacturers could be employed in Spokane which could quadruple the capacity. Large regional contract manufacturers could also be employed if the demand existed.

ReliOn fuel cells are made from common materials using mature manufacturing processes in injection-molded plastic, sheet metal fabrication and printed circuit board assembly. The PEM's are purchased through a supply agreement with 3M. Minor capital expenditures are required to expand production.

4.0 Principal Investigator(s)

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Title	Program Manager
Company	ReliOn, Inc.
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Name	Scott Cochran
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5.0 Authorized Negotiator(s)

Name	Frank Ignazzitto
Title	Vice President, Government Sales
Company	ReliOn, Inc.
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6.0 Past Relevant Performance Information

- 242nd Combat Communications Squadron; Geiger Field, WA, Building 401

On March 29, 2002, ReliOn, then named Avista Labs, commissioned a 3kW, SR-72 fuel cell system with funding from the Construction Engineering Research Lab, a division of the U.S. Army Research and Development Engineering Center. The purpose of the installation was to demonstrate the viability of PEM fuel cell systems as a reliable source of power to various Department of Defense installations. Additionally, this installation would provide long-term test data of ReliOn's unique, modular PEM fuel cell system. A major project deliverable dictated the fuel cell provide over 90% availability to its specific customer loads. Specific loads powered included building lighting, building bay doors, and the building Local Area Network (LAN) switch. The system was operational for one year commencing on March 29, 2002 and maintained an uptime of 92.87%.

Company: U.S. Army Corp of Engineers, Construction Engineering Research Laboratory
Contract Number: DACA42-02-C-0002
Dollar Value: $184,300
Contact: Dr. Mike Binder
Title: Program Manager
Phone: (217) 373-7214
E-mail: m-binder@cecer.army.mil
Project Capacity: 3 kW
Date Installed: 29 March 2002

- SGS Future Installation; Cavalese, Italy

In November 2002, ReliOn, then named Avista Labs, completed the commercial sale of 13 Independence 1000 fuel cell systems to SGS Future, one of our distribution partners. Ten of these systems were installed in a parallel configuration providing 10kW of power for an installation near Cavalese, Italy. The fuel cells provide power to a mountaintop alpine lodge. Backpackers utilize the lodge, and it was desirable to employ an environmentally clean, quiet, reliable power source. The system has been installed and was operating at the end of 2002. The system was restarted in the spring of 2003. The dollar value below reflects only the cost of the fuel cells. Installation and enclosure costs were paid to a third party contractor by the customer, and not disclosed to ReliOn.

Company: SGS Future
Contract Number: N/A
Dollar Value $101,226
Contact: Dr. Andrea Tomasi
Title: Project Manager
Phone: +39 (046) 131-4489
E-mail: tomasi@itc.it
Project Capacity: 10 kW
Date Installed: 15 November 2002

- Federal Aviation Administration (FAA); McChord AFB, WA, Radio Transmit Receive (RTR) Site

On January 14, 2003, ReliOn, then named Avista Labs, installed a 3 kW fuel cell system consisting of six, Independence 500 fuel cells at McChord Air Force Base in Tacoma, WA. The formal commissioning ceremony occurred April 17th, 2003. Funding for this project was obtained from the Construction Engineering Research Lab, a division of the U.S. Army Research and Development Engineering Center. The six Independence 500's are connected in parallel to the FAA's RTR battery system. These batteries serve as a means of backup power in the event of a loss of AC power. Additionally, the fuel cells are connected to a load bank independent of the FAA's system. Six days a week, three times a day, the installation will simulate a loss of AC power and the fuel cell system will start up and provide power to the load bank for twenty minutes. Every Sunday, the installation will simulate a loss of AC power and the fuel cell system will provide power to the FAA battery bank for one hour. This installation makes clear the technical viability and cost savings of utilizing ReliOn's hydrogen-fueled PEM fuel cell systems in lieu of large lead acid battery systems. The purpose of the demonstration is to provide reliability data to both the FAA and the DoD to initiate commercial purchases of the ReliOn Independence fuel cell systems.

Company: U.S. Army Corp of Engineers, Construction Engineering Research Laboratory
Contract Number: DACA42-03-C-0001
Dollar Value: $136,342
Contact: Frank Holcomb
Title: Electrical Engineer
Phone Number: (217) 352-6511, 7412
E-mail: Franklin.H.Holcomb@erdc.usace.army.mil
Project Capacity: 3 kW
Date Commissioned: 17 April 2003

7.0 Host Facility Information

Location

Francis S. Gabreski Airport / Air National Guard Base, Long Island, New York

Pavehawk lifts a Rescue Jumper and the downed pilot he "saved". *Photo by Walt Wheeler*

History

Gabreski Air National Guard Base is the home of the 106th Rescue Wing. The 106th Rescue Wing, New York Air National Guard, is the parent organization of the Oldest Air National Guard unit in the Country, the 102nd Rescue Squadron which traces its roots back to the 1st Aero Squadron which was formed in 1908 in New York.

The peacetime mission of the 106th Rescue Wing is two-fold. Firstly, it is tasked with conducting Search and Rescue (SAR) and Medevac Operations in an area delineated from the Northeast United

States, south to the Bahama Islands and east to the Azores. The unit is able to provide long range rescue due to its air refueling capability.

The 106th RQW is also tasked by the New Hampshire Fish and Wildlife Service with conducting extensive mountain search support.

Secondly, the 106th Rescue Wing provides the Airborne Mission Commander (AIRBOSS) for every shuttle launch, as well as pararescuemen on board the HC-130 for deployment in the event of a Mode VIII event. Pararescue Jumpers are occasionally deployed to overseas locations during the launch to provide support to the Air Force.

The 106th is located in Westhampton Beach, Long Island, New York, which is approximately 80 miles east of New York City. The unit occupies one half of the Suffolk County airport named after Colonel Francis S. Gabreski, the leading living ace of World War II and Korea.

Gabreski ANGB Contacts:

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Contact:	LTC Jerry Webb
Telephone:	(631) 288-7470
Fax:	(631) 288-7599
Email:	Jerry.Webb@NYSUFF.ang.af.mil

8.0 Fuel Cell Site Information

The project at Gabreski ANGB consists of a backup power solution for the base telephone switch system. The base telephone switch is located in the 106th Communications Squadron building on Gabreski ANGB. The site will utilize four ReliOn Independence 1000 (1kW) fuel cell systems connected in parallel as a 4 kW source of backup power. The fuel cell systems will be housed in an outdoor enclosure that will be installed outside of the building.

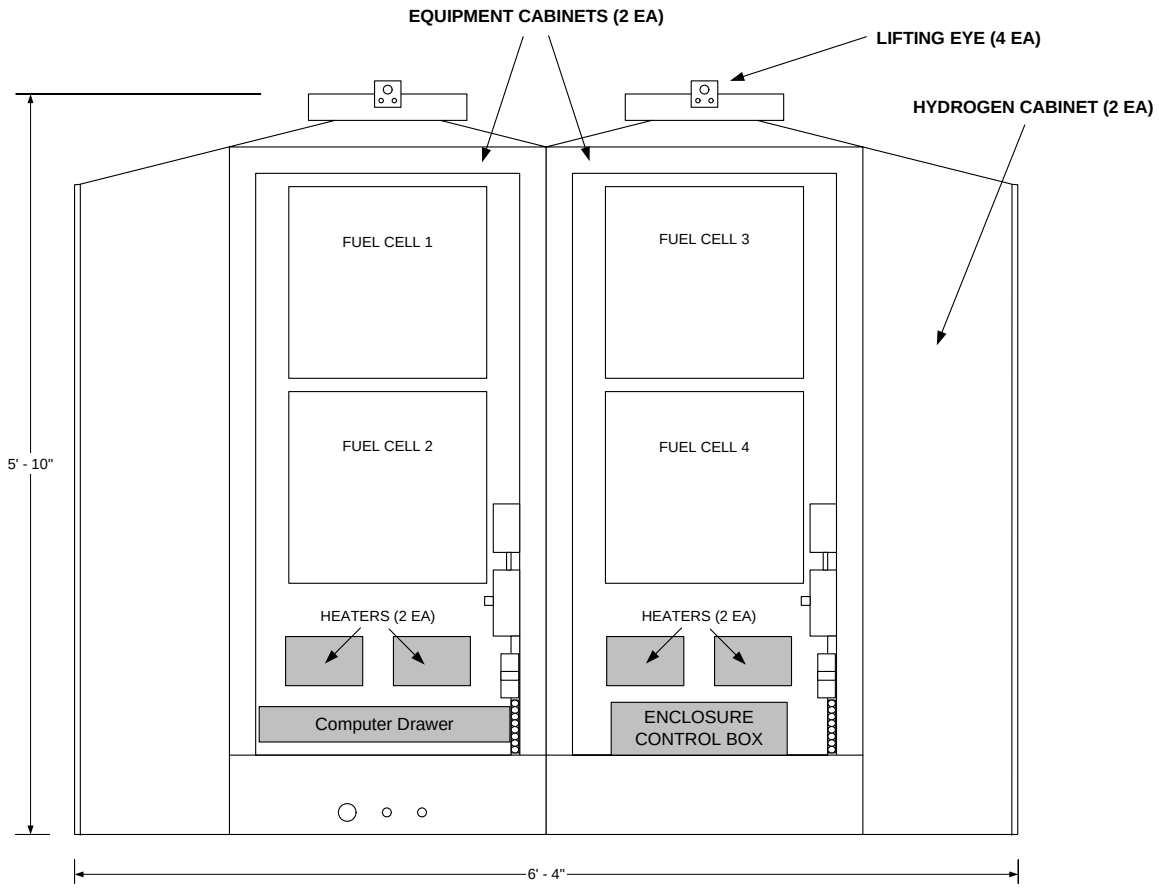
This project will test the reliability of the ReliOn backup power solution for the base telephone switch though an Uninterruptible Power Supply (UPS). The fuel cell systems will be connected though the DC connection on the UPS. The systems will be in an off, but ready state the majority of the time. The

system will be designed to start up and run for one hour a day, to test the availability of the fuel cell system. Data will be collected concerning start-up times, power availability, shutdown capability, system efficiencies, load following, and the effects of varying environmental conditions. If the system fails to start up properly or provide required power to the load this will be noted in the logs as a failure and count against the 90% availability of the system.

Gabreski Telephone Switch

Because ReliOn's PEM fuel cells operate at low temperatures, the system is not a cogeneration system. The system will be installed in an outdoor enclosure designed to maintain the internal temperature within the operating range of the Independence 1000.

The fuel cell outdoor enclosure with four Independence 1000s is shown below.



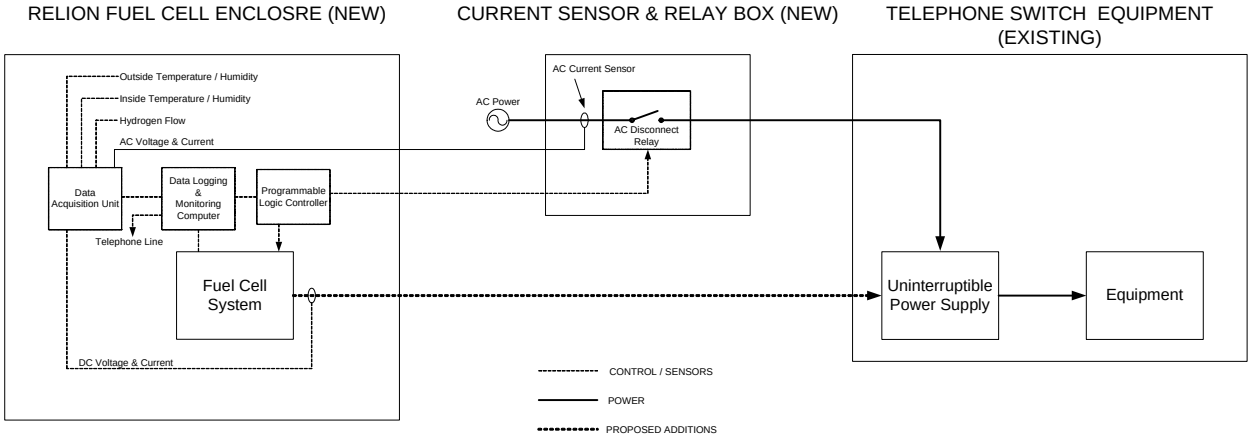
REAR VIEW

Integrated Fuel Cell and Hydrogen Storage/Delivery System:

- 2 Hydrogen Banks
- 6 cylinders total
- Each cylinder contains 261 cu-ft of hydrogen
- Total amount of hydrogen: 1566 cu-ft
- 48kW-hours of runtime capacity
- Composite Concrete Pad

The systems will be fueled from industrial grade hydrogen gas. Compressed gas is the easiest and most commercially available source of industrial grade hydrogen. Each system will be sited outdoors in an environmentally controlled enclosure placed on a composite concrete pad. The outdoor enclosure provided by ReliOn, will include a locked hydrogen storage and delivery system which ensures that the compressed hydrogen bottles are protected and accessible only to authorized personnel. On-Site maintenance will consist of routine visual inspections and occasional equipment adjustments. The ReliOn Independence series is a system based on removable cartridges that house the PEM membranes. If a membrane fails, the system continues to operate and there is a visual indication, as well as remote indication capability with the communications system. When it is convenient, the failed cartridge can be replaced. This task can be accomplished in less than one minute without the use of tools.

9.0 Electrical System



The fuel cell systems will run in a grid-independent mode with no interconnection requirements. The system will be in a standby/ready mode to provide backup power for critical DC equipment when there is a loss of primary AC power or low DC bus voltage. Electrical and communication connections between the fuel cell enclosure and the communications equipment room in Building 250 will be through dedicated conduit runs. The following connections will be required for the installation:

Electrical Requirements:

- One 15 – 20 Amp circuit required at each site for AC sense, powering the data monitoring computer, and the enclosure heater. The heater is designed to keep the environment around the fuel cell above freezing to facilitate startup. Once the fuel is running, it utilizes its own heat for operation.
- AC disconnect relay between AC power and the UPS
- The fuel cell enclosure will be grounded using a, install a new code-conforming ground stake located within the perimeter of the enclosure. Ground connection between the enclosure and the new ground stake will be made using a 1/0 AWG bare copper ground cable and a clamp or other approved connection compatible with local code and practice for equipment grounding.
- DC connection between fuel cell system and DC bus in customer's equipment cabinet

— All electrical work to be completed by a Contract Licensed Electrician

Telephone Lines:

— One phone line required for data monitoring, provided by Gabreski ANGB

— Commercial telephone service for the phone line, provided by ReliOn

— One computer with dial-up capability at each site, provided by ReliOn

Fuel Cell Installation Site

See Appendix 1 for site specific connections

10.0 Thermal Recovery System

Not applicable.

11.0 Data Acquisition System

The load for the telephone switch is approximately 3300 watts. A Programmable Logic Controller (PLC) will be used to start the fuel cell once a day for a test period of one hour. The PLC will also energize a relay at the same time to disconnect AC power from the telephone switch UPS.

A data acquisition system is also included in each enclosure to monitor and record the flowing:

- Inside temperature
- Inside Humidity
- Outside Temperature
- Outside Humidity
- AC Voltage at the site
- AC current at the switch UPS

- DC Voltage at the UPS
- DC current from the fuel cell

All vital information from the Independence 1000 fuel cells will also be monitored and recorded. The data-logging computer will be connected to the data acquisition module and fuel cell via Ethernet. The data-logging computer will be configured to dial out an alarm during any of the following conditions:

- Loss of AC Voltage
- Low DC Voltage
- Hydrogen Sensor Alarm
- Fuel Cell Major Alarm
- Hydrogen Bank Empty
- Enclosure Fan Alarm

The system will also be configured to start automatically during a loss of AC power and low voltage startup. The low voltage startup can be configured for 46, 48 and 50 VDC startup thresholds.

12.0 Economic Analysis

See Appendix II

13.0 Kickoff Meeting Information

Completed on 4 June 2004.

14.0 Status/Timeline

On or before:

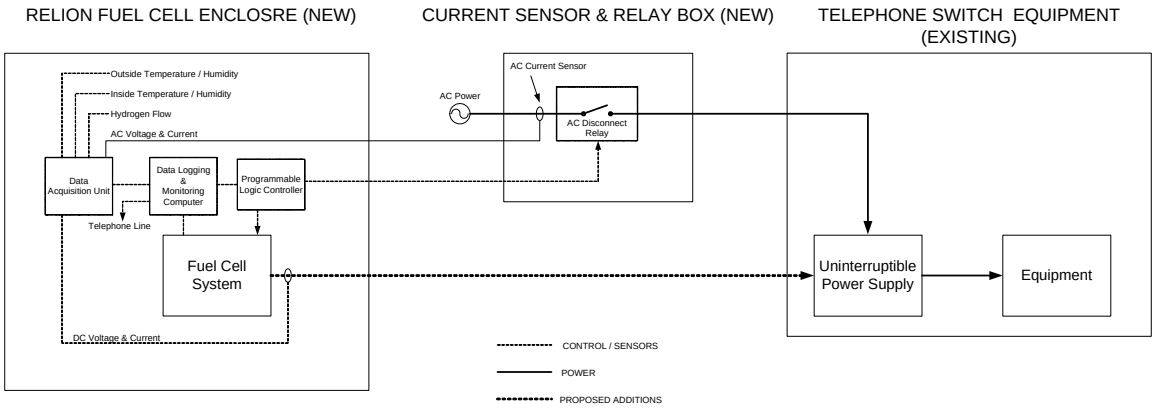
June 4:	Complete site layout Kickoff Meeting
June 28:	Review final drawings and contractor scope of work with base Select contractor
July 21:	Site preparation System installation and testing
August 13:	Commissioning ceremony Start of evaluation
August 13, 2005:	Site restoration begins

Appendix

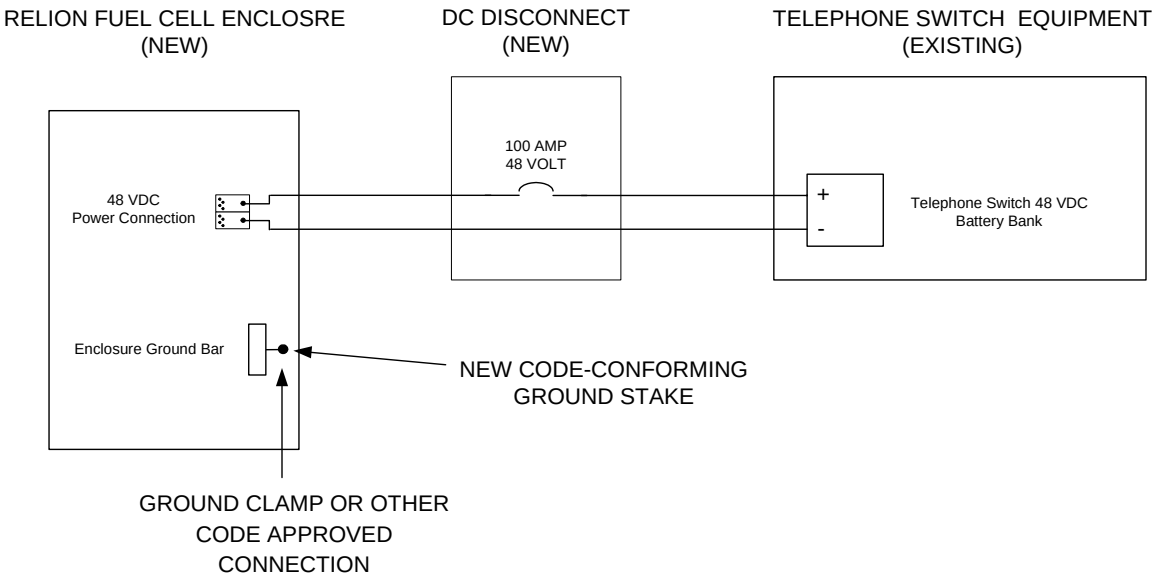
Appendix I: Electrical connections for the telephone switch fuel cell backup power system
Appendix II: Economic comparison versus extended battery bridge

APPENDIX I

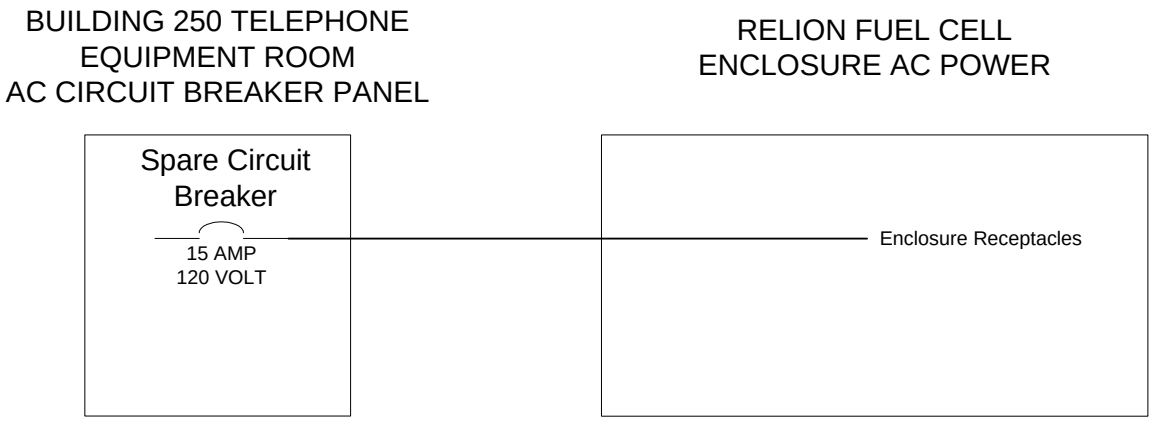
Functional Block Diagram



DC Power Connections



AC Power Connections



APPENDIX II

ReliOn Fuel Cells:

Telephone Switch (2004) - Generator with Battery String

Scenario

This analysis compares using a generator with lead acid batteries versus ReliOn modular fuel cells to back-up telephone switch equipment on military bases. Option A is a traditional approach consisting of a small string of VRLA batteries augmented by an engine generator. The engine generator is a small 5kW AC generator. Maintenance is calculated based on monthly checks on the engine generator and batteries. A monthly fuel service fee is assumed for the engine generator. The batteries in this option provide 4 hours of back up run time and are assumed to have a 5 year life.

Option B utilizes the ReliOn fuel cell solution to provide power capacity and hydrogen fuel to provide run time. Obtion B utilizes one hour of battery reserve to act as a battery bridge for startup of the fuel cell. Maintenance cost are reduced as the fuel cell can be remotely monitored and started to verify the working order of the system and check battery status. We will assume the loss of one modular cartridge every three years. Annual fuel usage is calculated assuming 4kW-hours per year.

Application Requirements:

Load (kW)	**4kW**
Run time (hrs.)	**12 hours minimum**
Discount Rate	**6%**

Option A Assumptions			
Engine Generator	$	10,120	(Based on Cummins Onan GCAC-1385 Generator)
Automatic Transfer Switch	$	2,400	(Industry data)
Fuel Storage Tank and Monitor	$	1,518	(15% cost of Generator system)
Battery Stack (16kWh * 1.2 = 19.2kWh)	$	6,720	(Based on $0.35/watt-hour; 5-Year Replacement)
Installation	$	20,400	(Based on fuel spill containment, generator install, electrical tie in, and battery connection)
Fuel Service	$	650	(Based on monthly fuel cycling)
Annual Maintenance	$	3,740	(Genset = $225/mo per MA/Com, Btry = quarterly service of 4 hours @ $65/hour)

Option A Cash Flows	**$**	**Y_0**	**Y_1**	**Y_2**	**Y_3**	**Y_4**	**Y_5**	**Y_6**	**Y_7**	**Y_8**	**Y_9**	**Y_{10}**
Capital Equipment	$	41,808					8,720					8,720
Other Initial Expenses												
Annual Expenses			4,390	4,390	4,390	4,390	4,390	4,390	4,390	4,390	4,390	4,390
Net Cash		**(41,808)**	**(4,390)**	**(4,390)**	**(4,390)**	**(4,390)**	**(13,110)**	**(4,390)**	**(4,390)**	**(4,390)**	**(4,390)**	**(13,110)**

Option A NPV **(85,504)**

Option B Assumptions			
ReliOn 4 x 1kW Hydrogen Fuel Cells	$	32,200	(List price)
1 Hour Battery Bridge	$	1,680	(Based on $0.35/watt-hour; 5-Year Replacement)
ReliOn Outdoor Enclosure	$	7,500	(List price)
Replacement Cartridge	$	300	(6-Year Replacement 1x$300)
Installation	$	9,000	(Includes site prep, pad, conduit)
Annual Maintenance	$	520	(Fuel cell system and batteries, 2 visits per year @ 4hrs/visit = $520)
Annual Hydrogen Fuel	$	585	(6 Cylinders; $5/bottle/month, Fuel & Delivery)

Option B Cash Flows	**Y_0**	**Y_1**	**Y_2**	**Y_3**	**Y_4**	**Y_5**	**Y_6**	**Y_7**	**Y_8**	**Y_9**	**Y_{10}**
Capital Equipment	50,965					2,200					2,200
Other Initial Expenses											
Annual Expenses		1,105	1,105	1,405	1,105	1,105	1,405	1,105	1,105	1,405	1,105
Net Cash	**(50,965)**	**(1,105)**	**(1,105)**	**(1,405)**	**(1,105)**	**(3,305)**	**(1,405)**	**(1,105)**	**(1,105)**	**(1,405)**	**(3,305)**

Option B NPV **(62,611)**

Option A NPV	**(85,504)**
Fuel Cell Advantage/Disadvantage	**22,893**

Savings = **27%**